

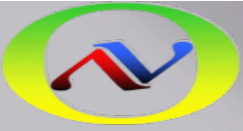
STATUS OF THE NO ν A EXPERIMENT

D. Cronin-Hennessy

November 8, 2011

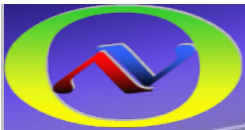
NNN11





Outline

- ▣ Overview
- ▣ NOvA technology and Far Detector status
- ▣ NDOS (Near Detector On Surface)
- ▣ Summary



NOvA Far Detector

MINOS Far Detector

Ontario

Minnesota

Wisconsin

□ NuMI Off-Axis ν_e
Appearance
Experiment

□ 810 km Baseline

□ 700 kW ν_μ beam

□ "Totally" Active
Liquid Scintillator
Detector

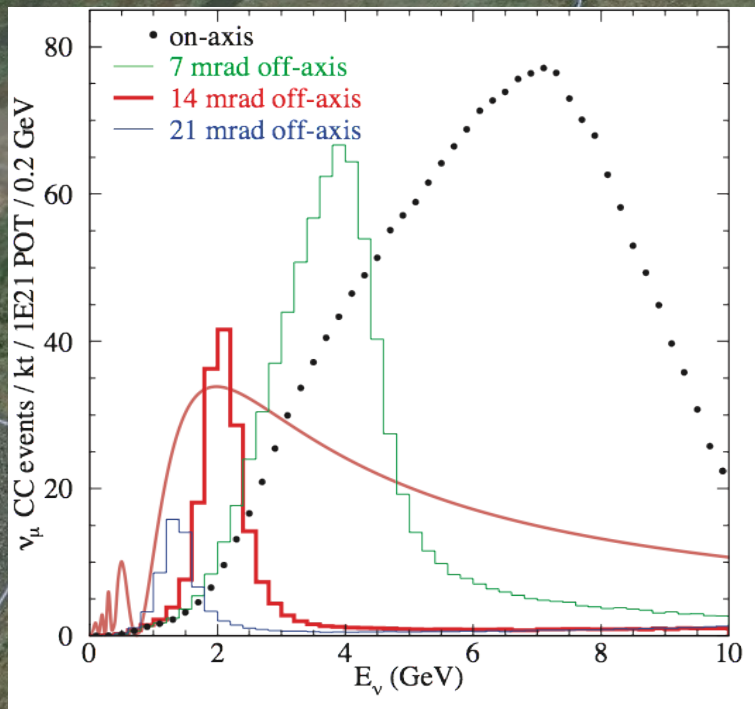
Milwaukee

Fermilab

Chicago

Michigan

Medium Energy Tune



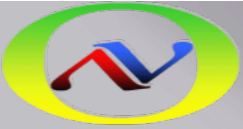
2007 Europa Technologies
Image © 2007 TerraMetrics
Image © 2007 NASA

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Pointer 43°34'32.84" N 89°04'55.60" W elev 271 m

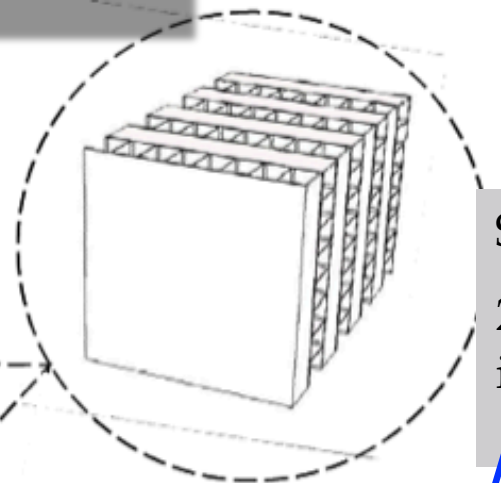
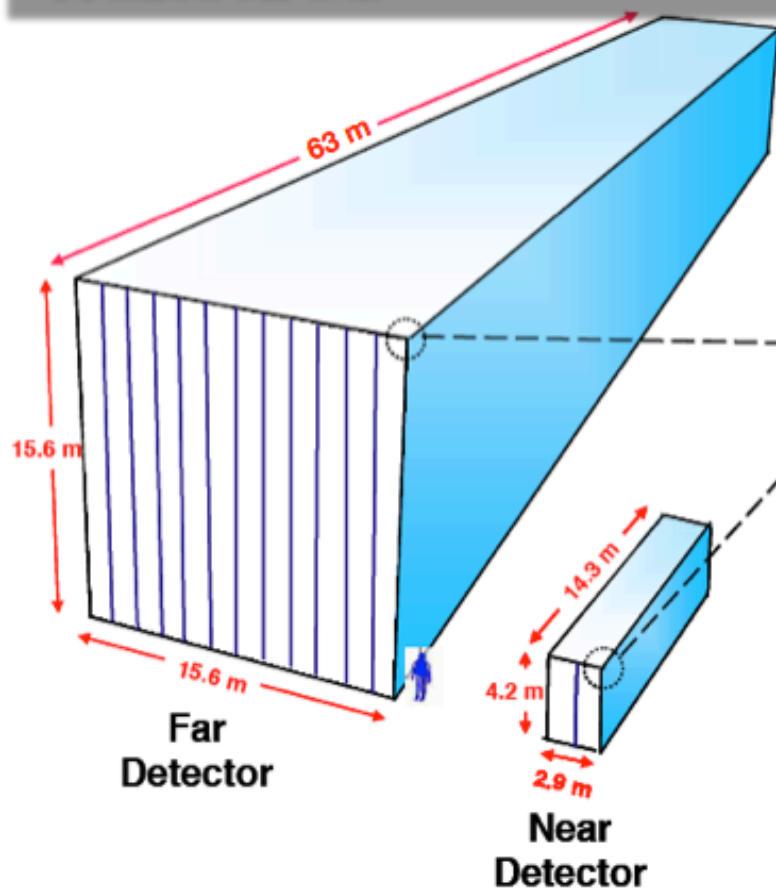
Streaming ||||| 100%

Eye alt 545.86 km

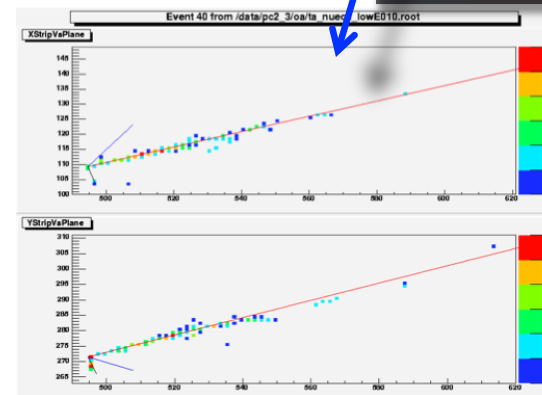


- NOvA is a 2nd generation neutrino experiment on the NuMI beamline at Fermilab.
- Mass ~15 kTon
- Liquid Scintillator tracking/calorimeter
- 14 mrad off-axis

Detector

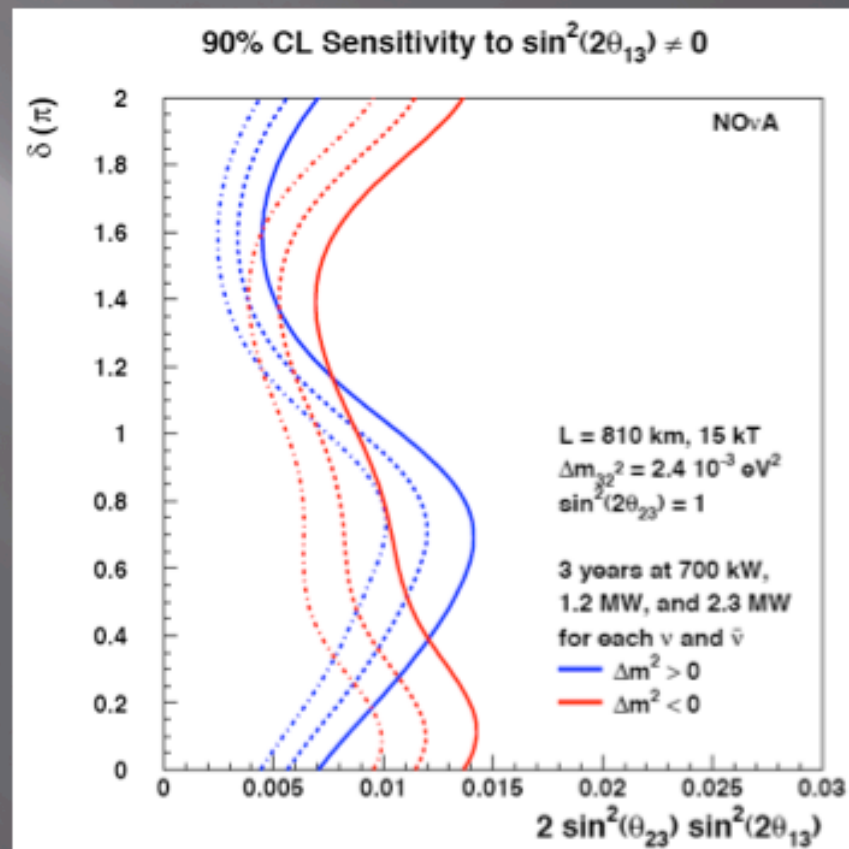


Simulated FD event
2.5 GeV CC ν_e
interaction



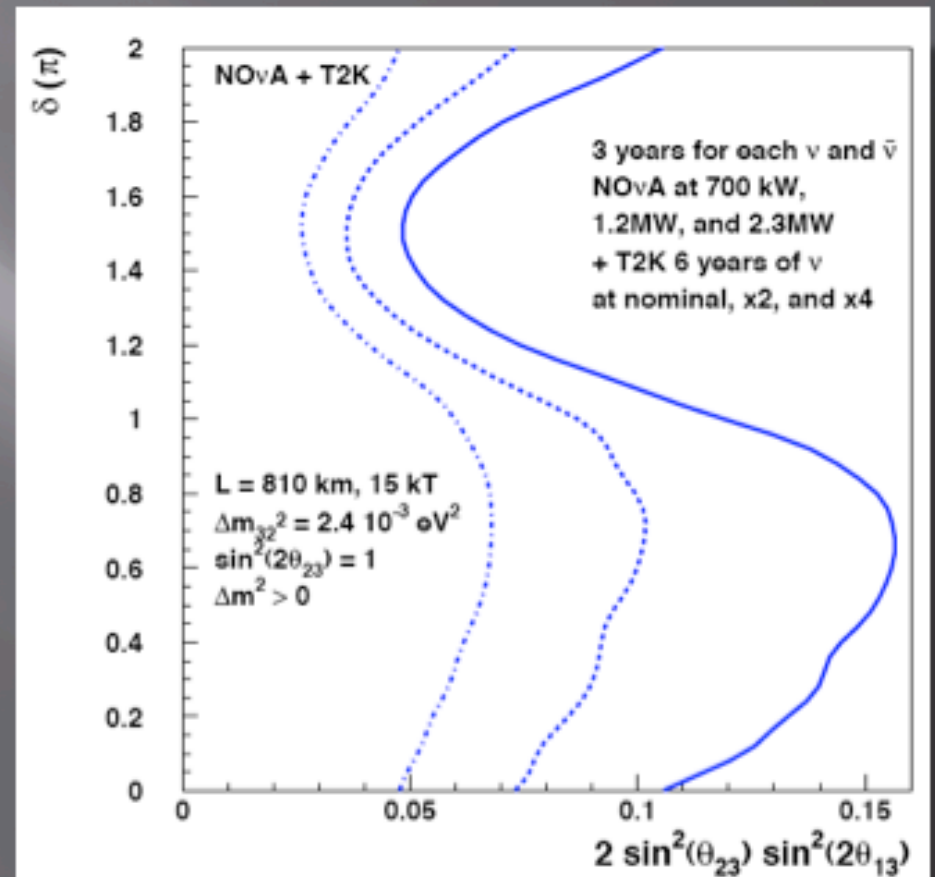
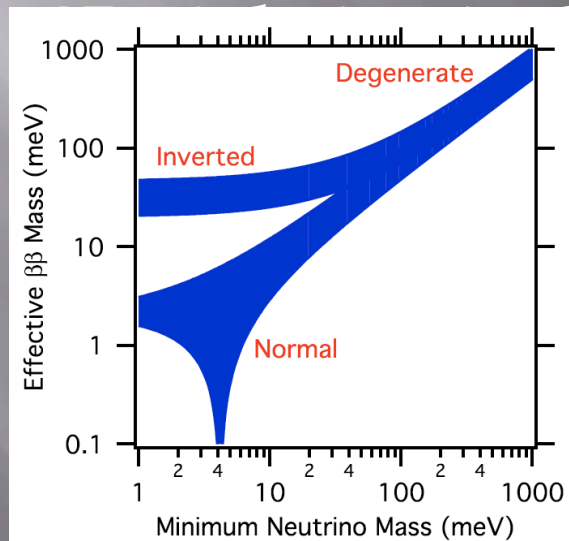
NO ν A Physics Potential

- Electron neutrino appearance
- Resolving the mass hierarchy
- CP violation in the lepton sector
- Significant improvement in θ_{23}
- Supernova neutrinos



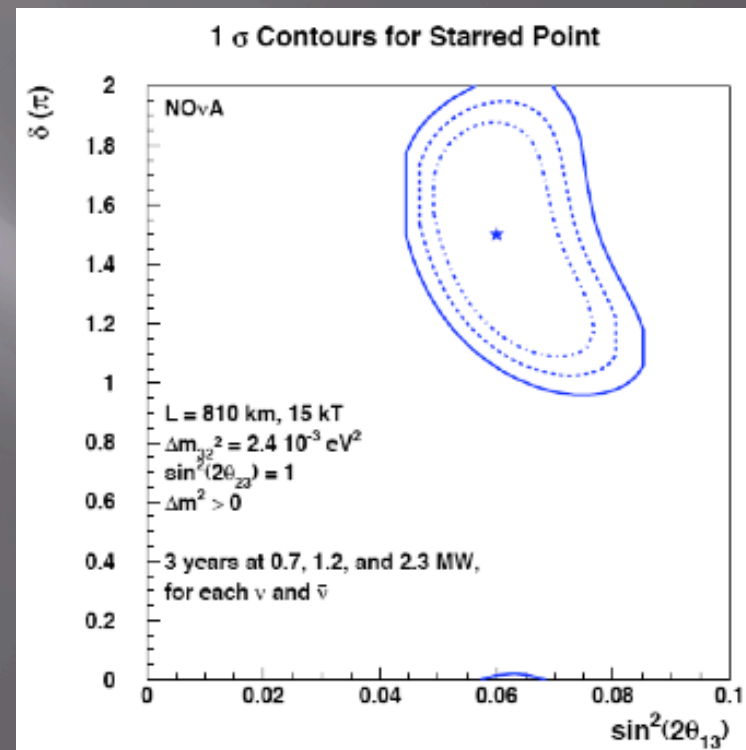
NO_νA Physics Potential

- Electron neutrino appearance
- Resolving the mass hierarchy



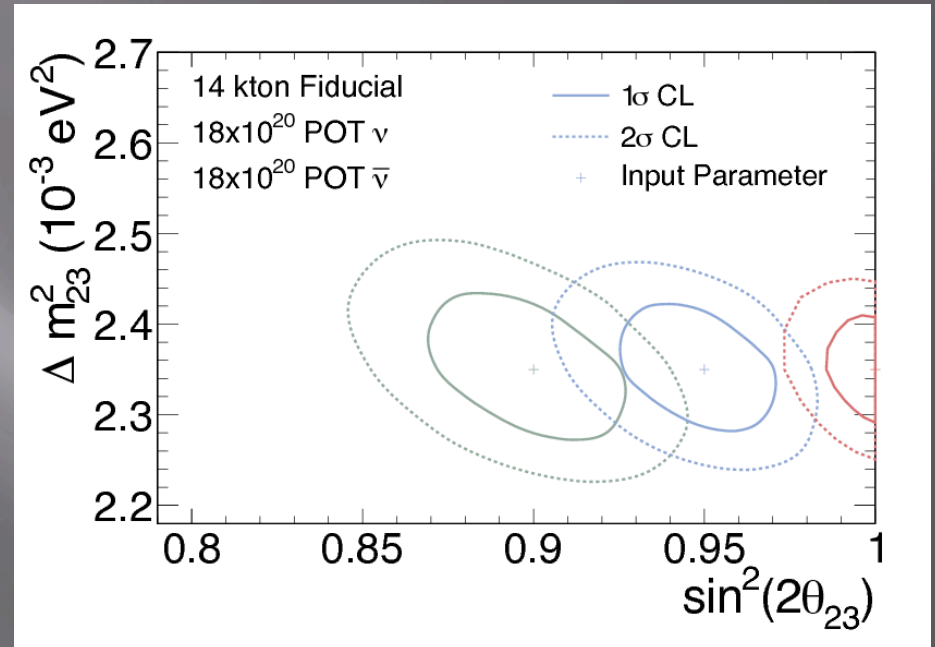
NO ν A Physics Potential

- Electron neutrino appearance
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NO ν A Physics Potential

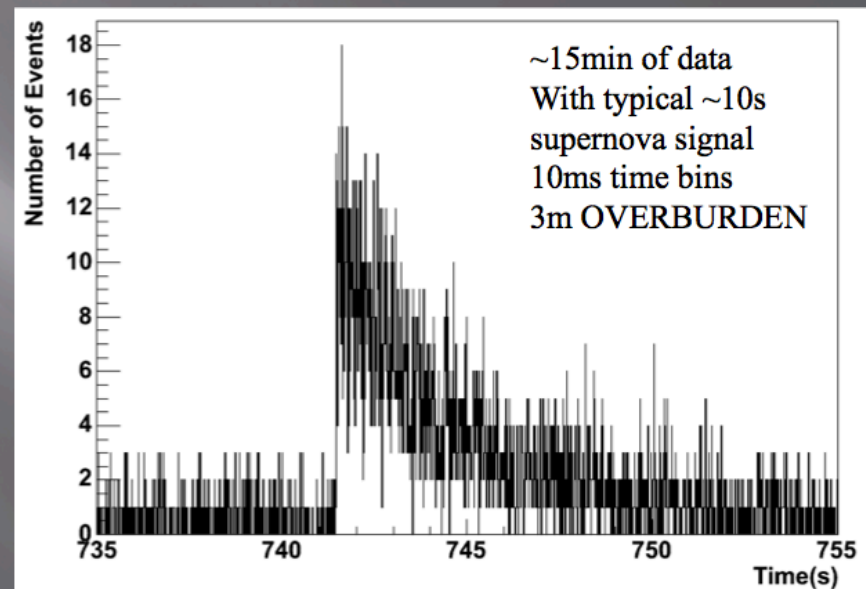
- Electron neutrino appearance
- Resolving the mass hierarchy
- CP violation in the lepton sector
- **Significant improvement in θ_{23}**
- Supernova neutrinos



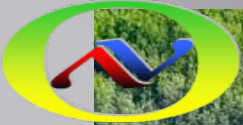
Improved energy resolution and well tuned beam will allow percent level determination of $\sin^2 2\theta_{23}$.

NO ν A Physics Potential

- Electron neutrino appearance
- Resolving the mass hierarchy
- CP violation in the lepton sector
- Significant improvement in θ_{23}
- **Supernova neutrinos**



5000 events for SN at galactic center

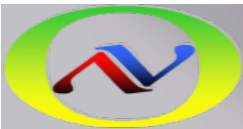


Far Detector Lab Complete

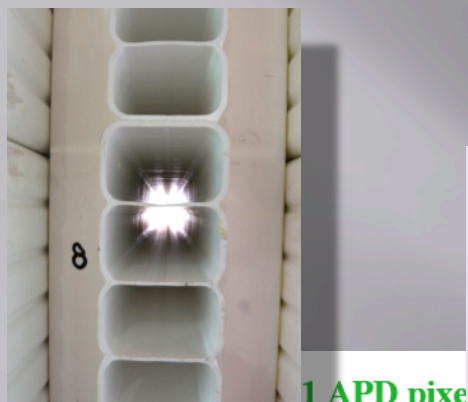


- ▣ Ash River, MN
- ▣ Occupancy in April 2011

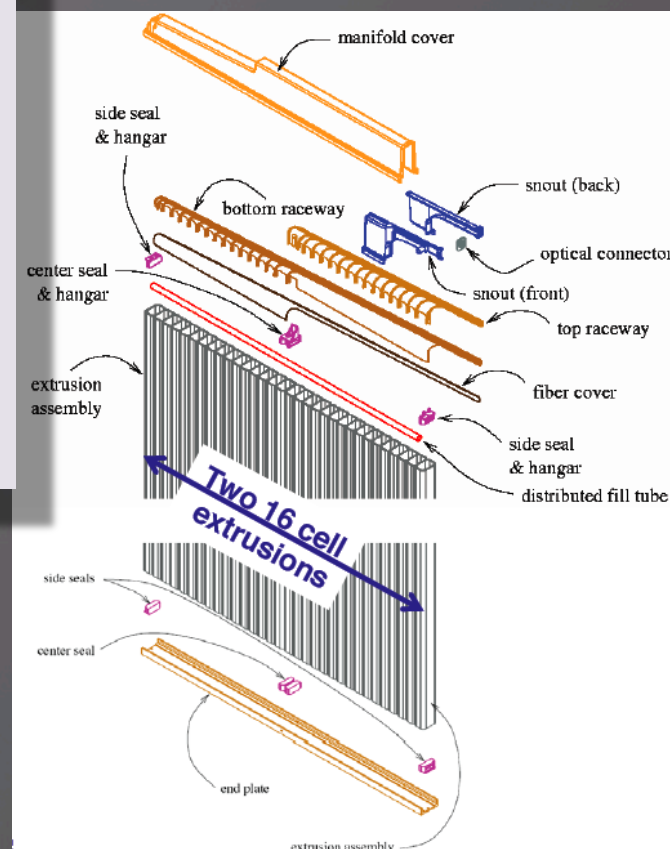
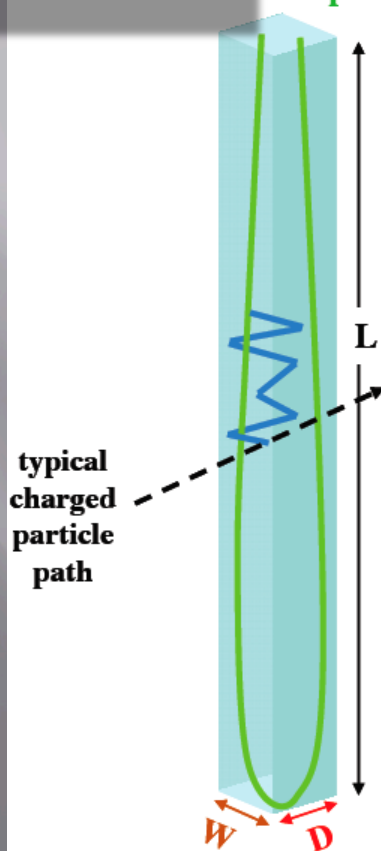


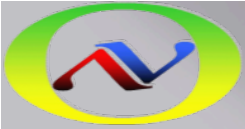


Module Details

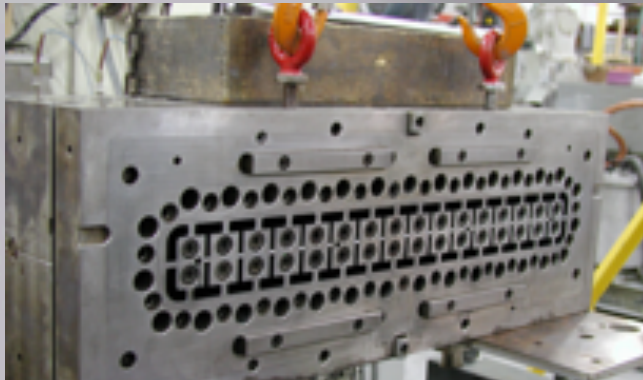


- Looped WLS fiber in liquid scintillator cell terminates at APD pixel.
- 32-cell module (15.6 meter long)
- 12000 Modules
- Avalanche Photodiodes (APD)
 - 85% QE for (520 – 550 nm)
 - Gain of 100 @ 375 volts.
 - Cooled to -15 C.
 - 38 pe signal far end of cell (10-15 pe thresh.)





Key Components



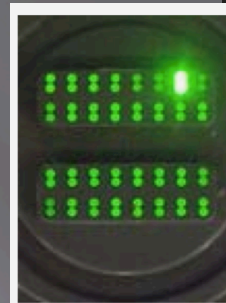
- ▣ Produced 1184 16-cell extrusions to specifications

- reflectivity
- dimensional tolerances

- ▣ Challenges:

- ensuring reliable knit lines
- rutile contamination levels in PVC resin

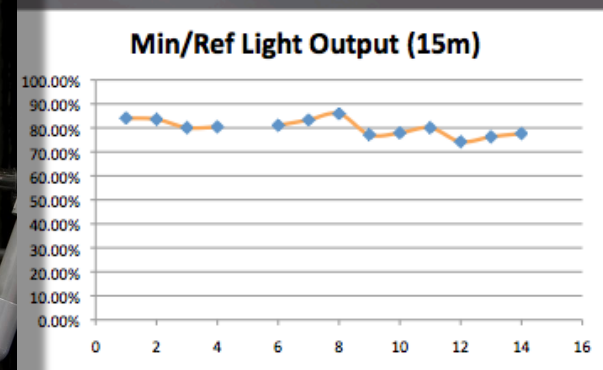
WLS Fiber
5,400 km delivered

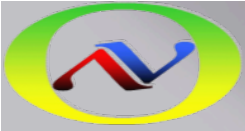


600 kGal Storage Tank

Scintillator

- FD contracts in place for mineral oil and pseudocumene.
- Received wavelength shifters
- QA/QC in place
- Produced NDOS scintillator





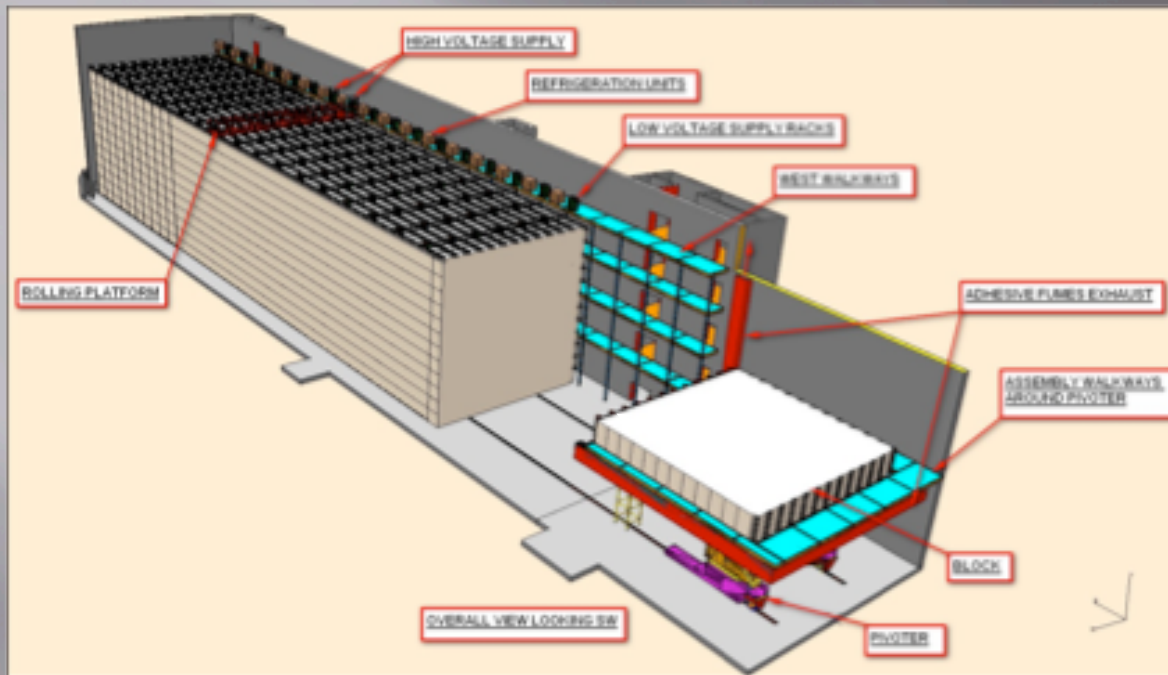
Module Construction



- ▣ Module Factory (120,000 sq ft):
- ▣ Fiber inserted and threaded, end seals installed, fiber manifolds assembled and attached.
- ▣ >200 Minnesota undergrads employed.

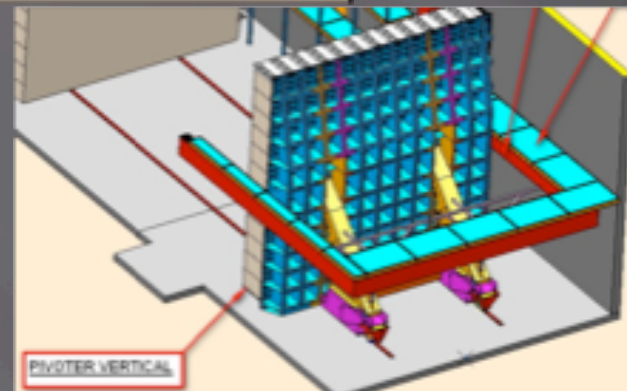


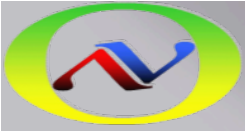
Block Pivoter



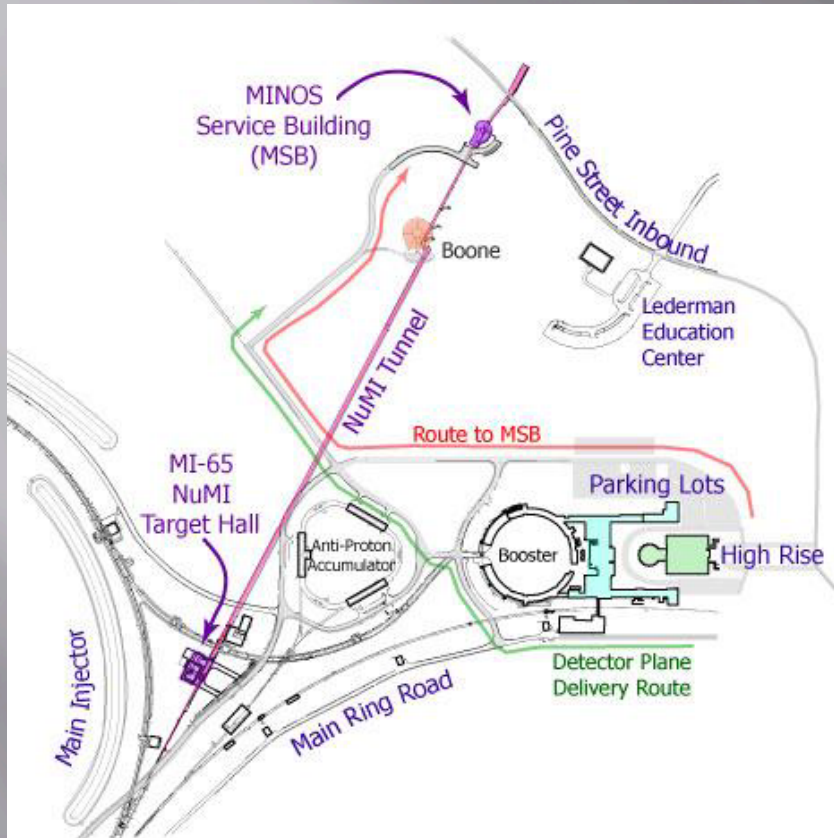
Prototype block-lifter^{work platform} constructed and tested.

Full size block pivoter is currently under construction





Near Detector On Surface (NDOS)

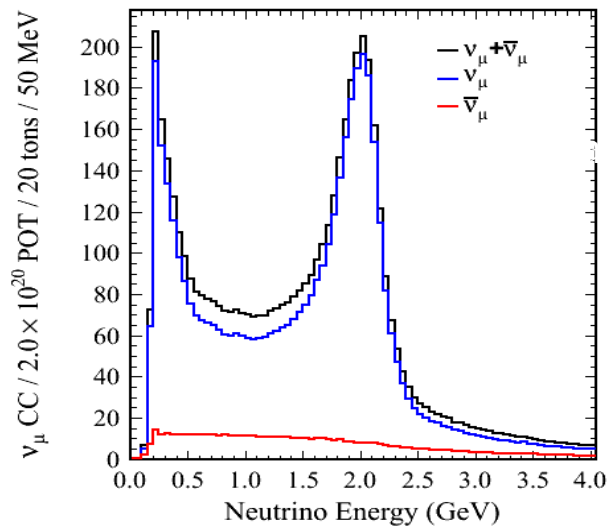


- NDOS (20 tons) is located in two neutrino beams. NDOS is 110 mrad off the axis of the NuMI beam. The Booster Neutrino Beam's (BNB) axis is oriented 23° with respect to the detector axis.. It has provided us an early look at neutrino interactions.

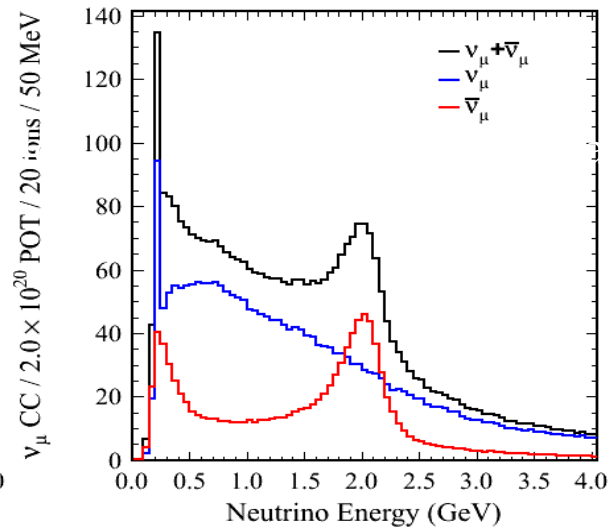


NDOS Neutrino Energy Profiles

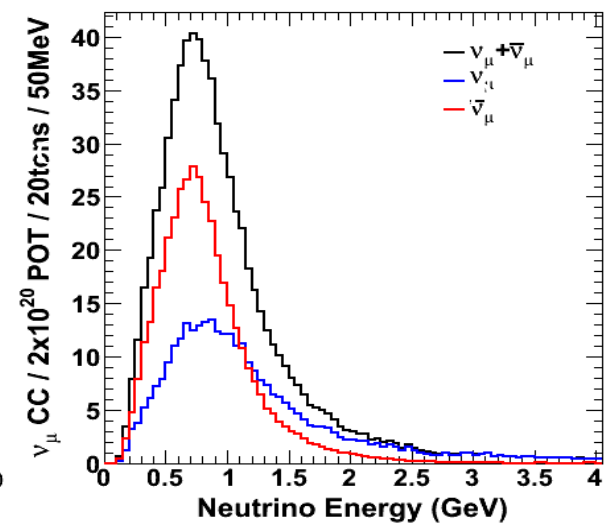
- ▣ Simulated NuMI beam for ν and $\bar{\nu}$ running (left and middle respectively)
- ▣ 2 GeV peak from kaon decay simulates well the expected 2 GeV peak for the actual beam.
- ▣ Shown on right is the BNB beam which peaks at 0.7 GeV
- ▣ 2×10^{20} POT simulated for each beam.
- ▣ Rates: 4300 (NuMI ν), 3300 (NuMI $\bar{\nu}$), and 750 (BNB ν).



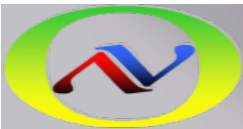
NuMI ν



NuMI $\bar{\nu}$

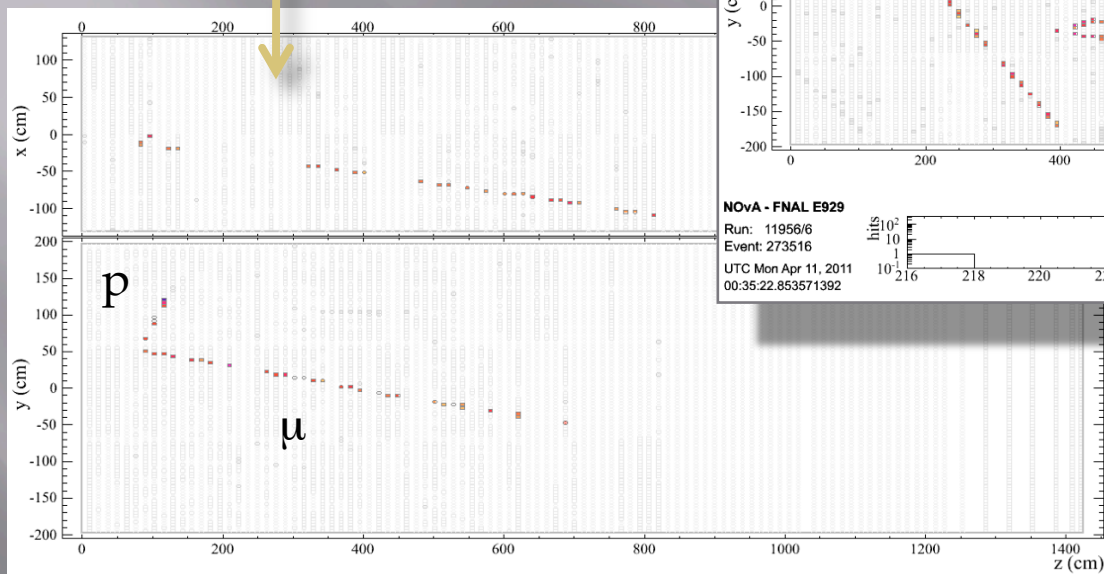


BNB ν



ν_μ Candidates

□ ν_μ quasi-elastic CC candidate



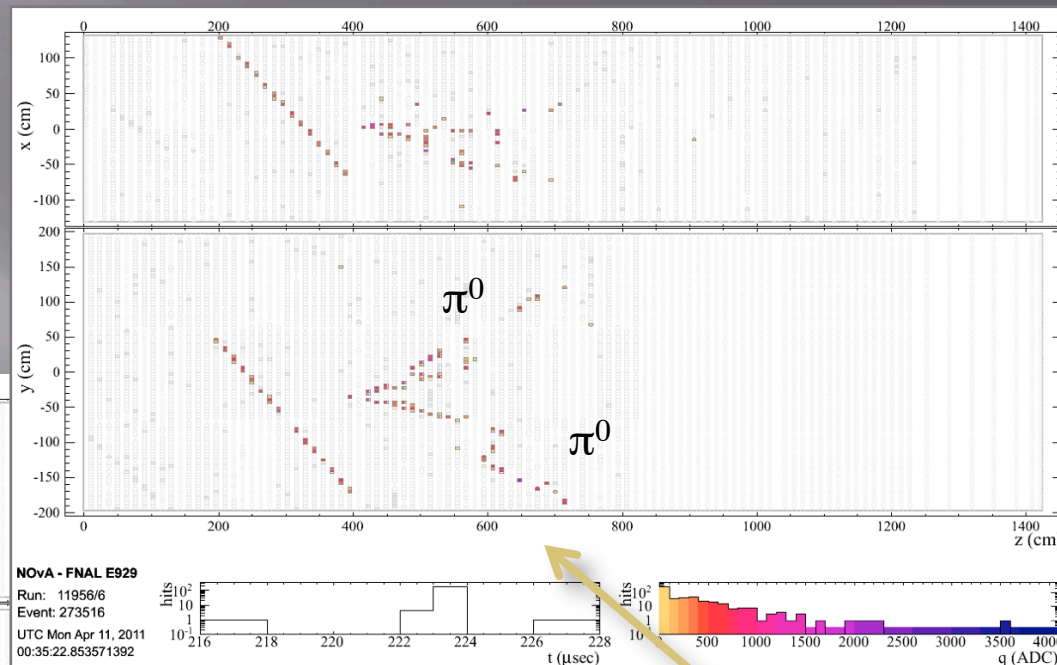
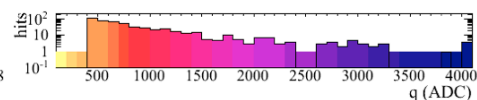
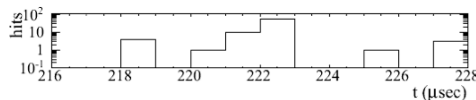
NOvA - FNAL E929

Run: 10893/8

Event: 314724

UTC Tue Dec 21, 2010

11:48:18.997623872



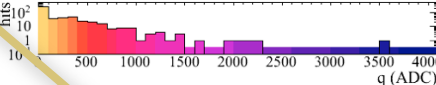
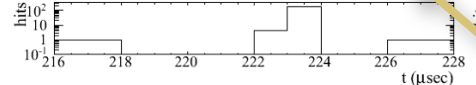
NOvA - FNAL E929

Run: 11956/6

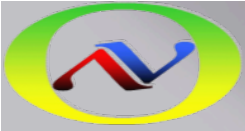
Event: 273516

UTC Mon Apr 11, 2011

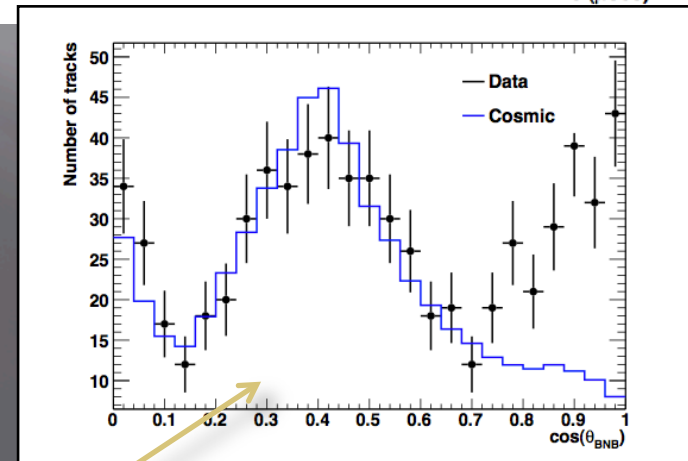
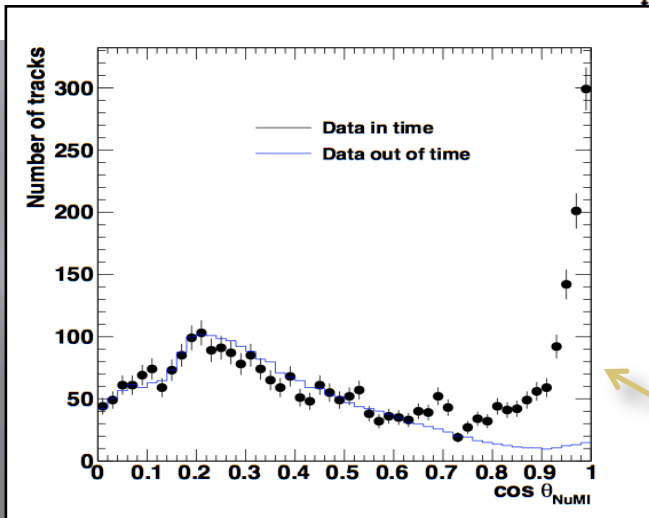
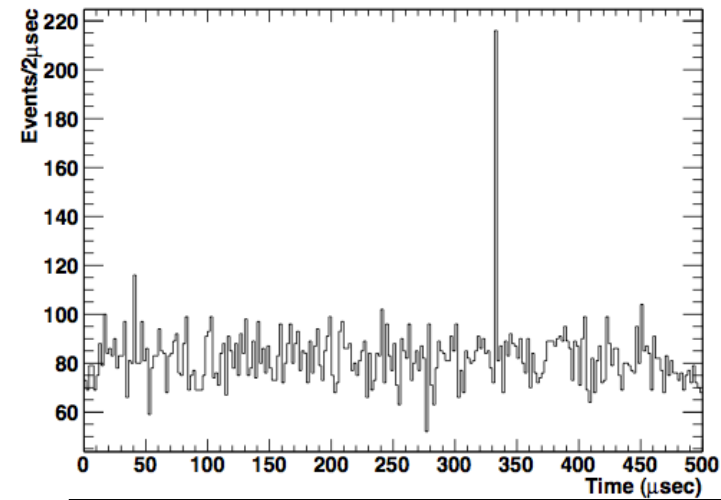
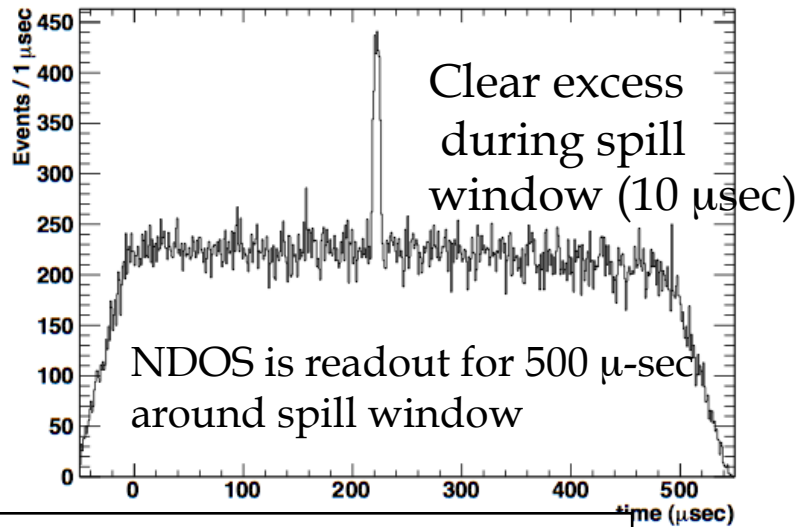
00:35:22.853571392



$\nu_\mu + N \rightarrow X \pi^0 \pi^0$
candidate



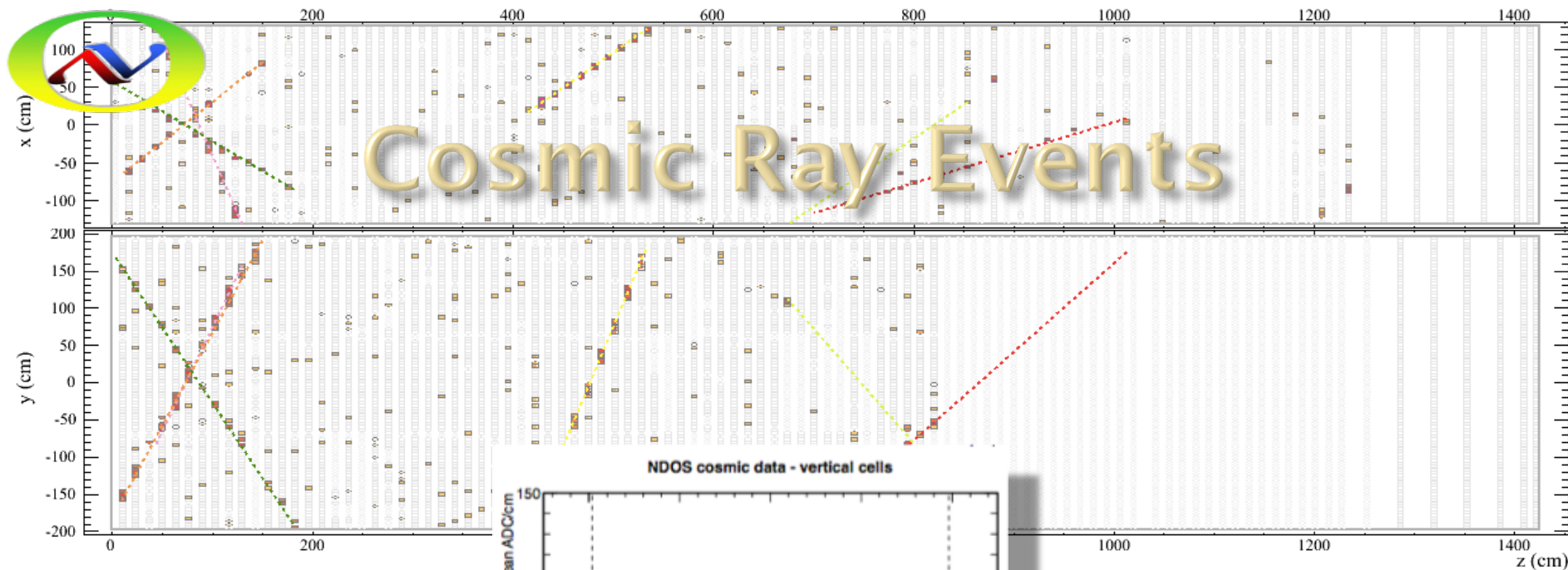
NDOS Events



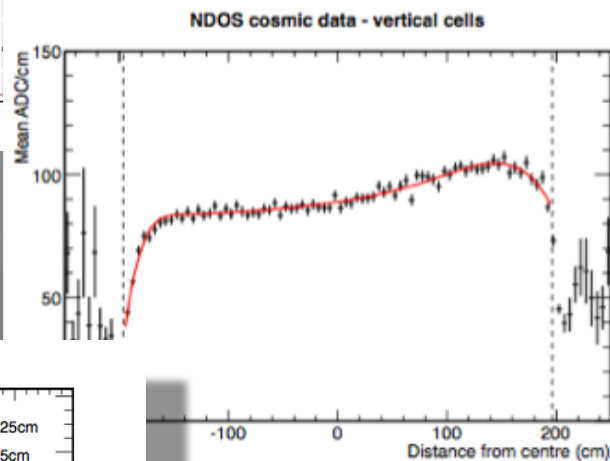
NuMI

BNB

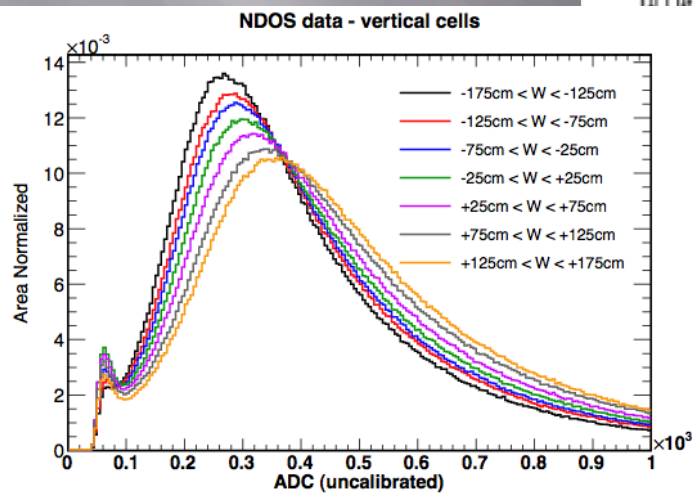
Track angle with respect to beam direction



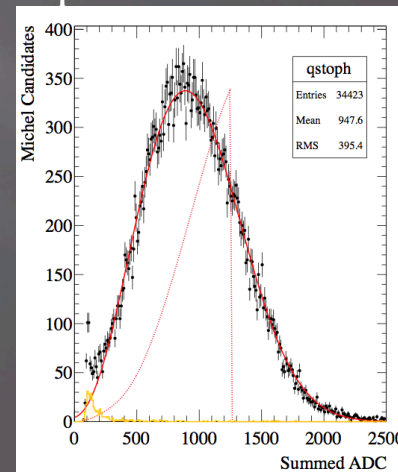
ADC output for various distances along fiber.

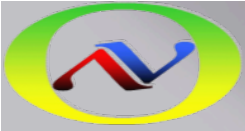


Michel electron energy spectrum.



Fiber attenuation calibration.

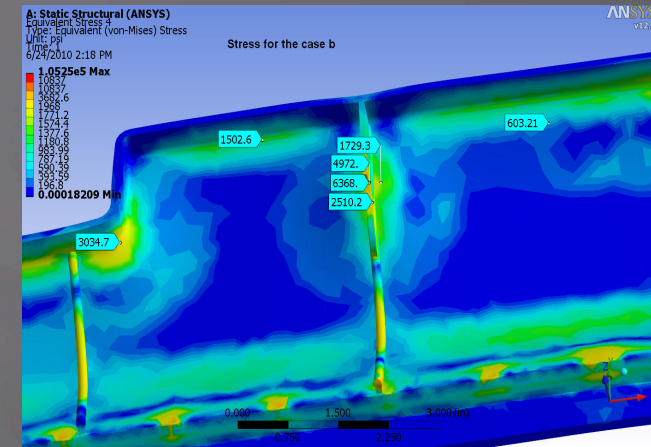




NDOS Summary

FEA of manifold during pressure testing.

- The prototype has allowed us to test the NOvA design.
- We now have first hand knowledge of module fabrication, component installation, scintillator filling and many other required skills. DAQ electronics and software are performing well .
- Some significant problems were identified.
 - Module manifold cracks developed (repaired).
 - this resulted in new manifold design which removes stress concentrators, a new injection mold scheme, stronger pvc, modifications to pressure testing procedures and improved containment during pressure testing.
 - APD's exposed to significant humidity levels.
 - Some failures in seal during installation were identified.
 - A leak path through electrical leads in heat sink were identified.
 - We are implementing modifications in the installation procedures and in the designs of these components. Future APD's will be clear-coated.



Summary and Future

- ▣ NOvA is designed to address a variety of significant neutrino physics issues.
- ▣ The NDOS has provided valuable experience with detector construction, DAQ, and actual data.
- ▣ Far detector lab complete
- ▣ NDOS complete and will continue running

Schedule

- ▣ Far detector module construction begins in Jan 2012
 - We have already started some manufacturing steps.
- ▣ Plan to have first block in place by the March 2012 shutdown.
- ▣ NuMI upgrade to 700 kW begins in March.
- ▣ Near Detector cavern will also occur during shutdown.
- ▣ ~ 5kT completed at time of NuMI upgrade.
- ▣ Detector completion by end of 2013.